

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface;

wherein, light coming from said second reflecting surface passes out of an effective diameter of said first reflecting surface, and said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein said catadioptric type optical system and said refraction type optical system are disposed on a single linear optical axis.

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19. (Amended) A catadioptric optical system according to Claim 18, wherein said catadioptric type optical system includes a lens group including at least one positive lens,

and said refraction type optical system includes an aperture diaphragm.

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20. (Amended) A catadioptric optical system according to Claim 18, wherein an exit pupil of said catadioptric optical system is substantially circular.

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21. (Amended) A catadioptric optical system according to Claim 18, wherein the following condition is satisfied:

$$0.04 < |fM1| / L < 0.4$$

wherein $fM1$ is a focal length of said concave reflecting surface of said first or second reflecting surface, and L is a distance along the optical axis from said first surface to said second surface.

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22. (Amended) A catadioptric optical system according to Claim 18, wherein the following condition is satisfied:

$$0.6 < |\beta M1| < 20$$

wherein $\beta M1$ is a magnification of said concave reflecting surface of said first or second reflecting surface.

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~~23~~. (Amended) A catadioptric optical system according to Claim ~~18~~, wherein the following condition is satisfied:

$$0.3 < |\beta_1| < 1.8$$

wherein β_1 is a magnification of said catadioptric type optical system.

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24. (Amended) A catadioptric optical system according to Claim 18, wherein said catadioptric type optical system includes a lens group including at least one lens element whose surface is asymmetric, and said refraction type optical system includes at least one lens element whose surface is asymmetric.

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~~25~~. (Amended) A catadioptric optical system according to Claim ~~18~~, wherein at least one of said first and second reflecting surfaces is a concave reflecting surface that corrects positive Petzval sum created by said lens element.

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~~26~~. (Amended) A catadioptric optical system according to Claim ~~18~~, wherein the catadioptric optical system has both-sides telecentricity.

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27. (Amended) A catadioptric optical system according to Claim 18, wherein said refraction type optical system includes two kinds of glass material.

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28. (Amended) A projection exposure apparatus, wherein a catadioptric optical system according to Claim 18 projects a predetermined pattern on a mask onto a photosensitive substrate.

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29. (Amended) A catadioptric optical system comprising:
a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and
a refraction type optical system for forming an image of light coming directly from said second reflecting surface, onto a second plane surface which is substantially parallel to said first plane surface,

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wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface.

30. ¹⁶ (Amended) A catadioptric optical system comprising:
a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein said catadioptric type optical system and said refraction type optical system are disposed on a single linear optical axis.

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31. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface,

wherein said catadioptric type optical system includes a lens group including at least one positive lens, and said refraction type optical system includes an aperture diaphragm.

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33. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting

surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein the following condition is satisfied:

$$0.04 < |fM1| / L < 0.4$$

wherein $fM1$ is a focal length of said concave reflecting surface of said first or second reflecting surface, and L is a distance along the optical axis from said first surface to said second surface.

34. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface

passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein the following condition is satisfied:

$$0.6 < |\beta_{M1}| < 20$$

wherein β_{M1} is a magnification of said concave reflecting surface of said first or second reflecting surface.

35. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a

concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein the following condition is satisfied:

$$0.3 < |B1| < 1.8$$

wherein B1 is a magnification of said catadioptric type optical system.

36. (Amended) A catadioptric optical system comprising:
a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

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a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein said catadioptric type optical system includes a lens group including at least one lens element whose surface is asymmetric, and said refraction type optical system includes at least one lens element whose surface is asymmetric.

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37. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein at least one of said first and second reflecting surfaces is a concave reflecting surface that corrects positive Petzval sum created by said lens element.

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38. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein the catadioptric optical system has both-sides telecentricity.

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[Please cancel Claims 41 and 43 without prejudice.]

24 42. (Amended). A method of manufacturing a catadioptric optical system comprising:

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providing a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing out of an effective diameter of said first reflecting surface, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

providing a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first

plane surface and said second plane surface, and said catadioptric type optical system and said refraction type optical system are disposed on a single linear optical axis.

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44. (Amended) A method of manufacturing a catadioptric optical system comprising:

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providing a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

providing a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface,

wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

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wherein said catadioptric type optical system includes a lens group including at least one positive lens, and said refraction type optical system includes an aperture diaphragm.

46. (Amended) A method of manufacturing a catadioptric optical system comprising:

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providing a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

providing a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface, wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein said catadioptric type optical system includes a lens group including at least one lens element whose surface

is asymmetric, and said refraction type optical system includes at least one lens element whose surface is asymmetric.

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47. (Amended) A catadioptric optical system comprising:
providing a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

providing a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface, wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein at least one of said first and second reflecting surfaces is a concave reflecting surface that corrects positive Petzval sum created by said lens element.

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48. (Amended) A catadioptric optical system comprising:

providing a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting surface that reflects light coming from said first reflecting surface, light coming from said second reflecting surface passing said first reflecting surface off-axis thereof, at least one of said first and second reflecting surfaces being a concave reflecting surface, for forming an intermediate image from an object of a first plane surface; and

providing a refraction type optical system for forming a second image onto a second plane surface which is substantially parallel to said first plane surface, wherein, said catadioptric type optical system and said refraction type optical system are disposed between said first plane surface and said second plane surface, and

wherein the catadioptric optical system has both-sides telecentricity.

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50. (Amended) A catadioptric optical system comprising:

a catadioptric type optical system, which includes a lens element, a first reflecting surface and a second reflecting